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Effectiveness of a Blended Web-Based Intervention to Raise Sleep Awareness at Workplace: the WarmUapp™ Pilot Study

Objectives: This study aimed to describe a workplace intervention to sensitize employees to sleep problems, and to evaluate the medium-term impact of this intervention on participants' sleep status.

Methods: Employees of different sites (China, France, Spain, United Kingdom) of a multinational company were offered a face-to-face session on sleep hygiene with a health professional using a tablet application providing feedback by email. Data on sleep status were collected through an interactive questionnaire at baseline (N=834 participants) and at six-month follow-up (n=291, 34.9% retention). Descriptive statistics, a three-way ANOVA and a logistic regression model were performed.

Results: Sleep quality improved among followed-up participants. Statistically significant results concerned total sleep duration during week-end (P=0.046), sleep debt (P=0.019), sleep difficulties (P<0.001) and sleepiness (P=0.026).

Conclusions: Interventions blending face-to-face and web-based approaches show promise for effective promotion of sleep awareness at the workplace.

Keywords: sleep; workplace intervention; evaluation; wellness; employees; blended face-to face and web-based approaches

Running title: Workplace blended intervention on sleep

Introduction

Adequate daily sleep is an important part of a healthful and productive lifestyle. Many studies have explored the relationship between sleep and work[1] underlining the numerous psychological and physiological effects of sleep on productivity and organizational functioning[2]. The association between sleep problems (e.g. difficulty getting to sleep, insomnia, or sleepiness) and working conditions and performance is supposed to be bidirectional. On the one hand, shift work[3] and long working hours[4] can induce sleep complaints. On the other hand, sleep problems contribute to several negative occupational outcomes including excessive absenteeism[5], reduced work efficacy[6], and increased risk of accidents[7] and injuries[8], which all have a considerable economic impact for employers[9-11].

According to previous research, sleep problems are frequent among employees[12-14]with prevalence rates ranging from approximately 18% in Europe[15] to 36% in Asia[4]. Given the high rates of sleep problems and growing evidence of the importance of sleep among employees, during the 2010 World Economic Forum[16], insufficient sleep was recognized as one of the eight major employee behaviours that managers should address through appropriate health promotion interventions within their enterprises. Hence, sleep plays a critical role in the biggest organizational challenges of our time[1], from work-life integration[17] to stress and well-being[18].

Workplace health promotion interventions are defined by the World Health Organization as any activities or tools delivered in an occupational setting with the aim of improving the health and well-being of people at work[19]. There is convincing evidence that this type of interventions is efficacious[20] since they are reinforced by a supporting social and organisational environment like the occupational setting[21].Media technologies are praised in the literature for their potential for delivering efficacious messages to

promote physical and psychosocial well-being[22]. The Internet, apps, social media and digital tools in general can capture the attention of employees of enterprises which already use to a great extent digital technology. In line with this, many organizations are starting using digital interventions to leverage support for the health and well-being of their employees.

Empirical evidence suggests that the efficacy of stand-alone digital health interventions can be enhanced by the combination with conventional face-to-face approaches[23]. A few studies, mostly conducted in English speaking countries[24-26], have documented the impact of either face-to-face or digital workplace interventions to improve sleep, but, to the best of our knowledge, none has described the effectiveness of a multi-country intervention using both face-to-face sessions and web-based technologies.

Therefore, the aims of this study were: (1) to describe a workplace blended intervention to sensitize employees to sleep problems and their consequences; and (2) to evaluate the medium-term impact of this pilot intervention on the sleep status of participants.

In accordance with these aims, we hypothesized that our intervention, called Wellness solution to Assess, Record, Monitor & Adjust your Program at the work Place (WarmUapp™), would lead to (1) increased awareness of the harmful effects of lack of sleep, sleepiness and bad sleep quality, and (2) improved sleep status in employees undertaking the intervention.

Materials and Methods

The WarmUapp™ pilot intervention: rationale and staff

As part of its commitment to preserve employees' wellbeing through a health, safety and environment policy, since 2013 a multinational private company had developed its own workplace health promotion program targeting prevention of non-communicable diseases[27]. The program consisted of ad hoc worksite pilot interventions using face-to-face consultations and media technologies to provide advice and information to employees on six specific health domains: physical activity, nutrition, sleep habits, stress management, smoking cessation and vaccination.

This paper focuses on the WarmUapp™ pilot intervention concerning sleep habits. WarmUapp™ was aimed to raise awareness on sleep problems and their consequences by (1) assessing employees' sleep status through a tablet application, (2) alerting them to possible risks linked to sleep problems through a face-to-face consultation, and (3) delivering tailored educational and lifestyle feedback and recommendations by e-mail to lower such risks and improve sleep hygiene. WarmUapp™ was tested in 2017 in eight company sites of four countries: four sites in China, two sites in France, one site in Spain and one site in the United Kingdom. The sites were either Research & Development or Manufacturing or Marketing sites. Each site received instructions from the headquarters WarmUapp™ committee and built a local team in charge of adapting and implementing the pilot intervention. The WarmUapp™ committee provided local teams of each site with initial support to set up a program to be adapted to local needs. Local teams were composed of both company staff (managers, human resources, and communication and information technology officers) and health care professionals (occupational doctors and nurses). WarmUapp™ targeted all employees aged between 18 and 64 years (permanent contract, fixed-term contract, apprenticeship

contract, temporary employees, service providers and trainees) of the eight sites without gender distinction. Participation was voluntary with no exclusion/inclusion criteria. All materials to deploy the interventions were translated into local languages (Chinese, English, French and Spanish).

Intervention design: blending human and web-based approaches to promote health

The intervention comprised two phases at each worksite. The first phase (baseline, T0) took place between May and September 2016, while the second phase (follow-up, T1) was conducted six months after, between February and May 2017. Both phases lasted 5 days each. Since the intervention was not carried out at the same time in all sites, participants were asked not to inform their international colleagues on the content of the intervention in order to prevent contamination.

The first phase (T0) consisted in a face-to-face meeting between each participating employee and a health care professional. Each meeting lasted 20-25 minutes. First, the health care professional introduced the objectives of the intervention. Second, (s)he asked the employee to use the WarmUapp™ tablet application. Third, the health care professional commented on the individual electronic report produced by the tablet application, and provided recommendations before closing the first phase of the intervention. The report and general advice on sleep hygiene were also printed and handed out and sent anonymously to the electronic mail address of each employee. The content of the tablet application (including the report) is described below.

The second phase (T1) concerned only employees having taken part to the first phase who underwent the same procedure: face-to-face meeting and use of the tablet application. At the end of this phase, differences in the results between the two phases were discussed with the health care professional.

Participant recruitment

To optimize recruitment, the recruitment strategy combined advertising, direct communication through ambassadors, and promotional messages from local management. The WarmUapp™ committee provided local teams of each site with a tool box including basic communication supports (brochures, pull-up banners and posters in local languages). The brochure was especially important since it explained how the intervention would be conducted, what was expected from volunteers and what benefits could be gained from the intervention. To maximise the diffusion of the program and the recruitment of participants, some employees volunteered to become ambassadors of the intervention, acting as a communication link between potential participants and the WarmUapp™ local teams. The ambassadors were also in charge of the technical and logistical arrangements of the intervention. Site directors and managers championed the program for boosting recruitment. One month before the launch of the first phase, all employees of the involved sites were sent an electronic mail explaining the study. The invitation was reinforced by the ambassadors as well as pull-up banners and posters displayed in common meeting spaces, e.g. canteens. News and posts were also published on the official website and social network pages of the company. Only for French sites, a famous athlete was employed as the program sponsor to amplify the recruitment campaign. He acted in a video posted on the official website to promote a healthy lifestyle as a key driver for better work performance. In some sites a conference was organised just before the event to provide participants with the opportunity of meeting the intervention team. The rationale and the practical details were again provided to the participants. Finally, in all sites, participants were given some incentives (sport backpacks, sports towel or fitness material) at the end of the first phase. The same

communication strategy was adopted for the second phase addressing new participants exclusively employees who had taken part to the baseline as well as new participants.

This study included only individuals with two measurements.

Description of the application and collected variables

The tablet application consisted in a total of 27 screens (23 screens for questions, three screens providing partial survey answers, and one final report screen with full survey results and personalised recommendations). The first screen corresponded to a form to collect personal details including sociodemographic information: nation and workplace site codes, family and given names, age in categories (18-34, 35-44, 45-54, 55-64), sex (male, female), height in meters and weight in kilos. Participants were asked to provide information on their sleep characteristics by answering a short questionnaire divided into three blocks for a total of 22 screens: block one on sleep time during the week and during the weekend (nine questions/screens), block two on sleep quality (five questions/screens) and block three on sleepiness (eight questions/screens). After each block, a screen presented partial survey answers. Participants could not skip any question and answers were mandatory to complete the survey. Figure 1 illustrates some screenshots of the WarmUapp™ tablet application.

[Insert Figure 1 near here]

Once the whole questionnaire was completed, results were displayed on a final report including a description of participants' sleep status and tailored advice to improve their sleep quality inspired from the Centers for Disease Control and Prevention[28]. Partial and final results were calculated through an algorithm providing precise scores of sleep duration, quality and efficiency. Figure 2 shows an example of results report and recommendations.

[Insert Figure 2 near here]

Finally, we were able to collect information about work time during the week (number of hours per day) from a supplementary questionnaire employees completed for another workplace intervention on physical activity conducted in the same time span.

Measurement of sleep status

The short questionnaire on sleep habits and disorders (available as *Supplemental online material*) was produced by Pepin and colleagues[29]. Measurements were based on scientifically validated instruments[30] including the Epworth Sleepiness Scale[31] and the Pittsburgh Sleep Quality Index[32].

To measure sleep status in each participant, data collected through the tablet application were aggregated into five variables: total sleep duration (<5 hours, ≥5 hours and <7 hours, ≥7 hours); sleep efficiency (<85%, ≥85% and <90%, ≥90%); sleep debt (<90 minutes, ≥90 minutes and <120 minutes, ≥120 minutes); insomnia (no sleep difficulties, sleep difficulties, insomnia); and sleepiness (<10, ≥10 and <16, ≥16). Total sleep duration and sleep efficiency corresponded to questions of block one; insomnia to block two; and sleepiness to block three. Total sleep duration and sleep efficiency were distinguished in either during the week or during weekend to show differences by ordinary working days.

The National Sleep Foundation recommends that adults under age 65 years get 7 to 9 hours of sleep every night[33]. Accordingly, we defined as short-sleepers subjects reporting sleeping strictly less than 5 hours. Sleep efficiency was defined as the percentage of time spent asleep in bed. Sleep time is efficient when it is above 90% of time spent in bed[32]. Since sleep debt is poorly defined in the scientific literature[30,34], we assessed it as the difference between the average total sleep duration during vacations or weekend days and the average total sleep duration during working days. Insomnia was defined as a primary sleep disorder in which a person has difficulty in initiating and

maintaining sleep. It is characterized by difficulty falling asleep, waking up frequently during the night, waking up too early and being unable to get back to sleep, or non-restorative sleep. Sleep difficulties were identified for participants having answered affirmatively to at least one of the first three questions of the sleep quality block. Insomnia was identified if participants had answered "at least three times a week for more than one month" to the fourth of question, and affirmatively to the fifth question of this same questionnaire block. Finally, to measure sleepiness, we used the Epworth Sleepiness Scale[31] which describes the likelihood of falling asleep or dozing off in eight situations. The total score ranges from 0 to 24, with score <10 corresponding to an absence of sleepiness, a score ≥10 and <16 reflecting a moderate daytime sleepiness and a score ≥16 reflecting a more severe level of daytime sleepiness. Excessive daytime sleepiness refers to a symptom of increased sleep propensity when one's intention is to remain awake.

Evaluating WarmUapp™

The effectiveness of the intervention was evaluated by collecting, analysing and comparing the data collected during the two phases. As a complementary measure of user satisfaction, feedbacks and ideas from participants were also collected through a structured interview composed of a 3 open-ended questions and noted down in a qualitative report with verbatim. The questions were: "Why have you accepted to join this program?", "After the intervention, what changes have you made to improve your health?", and "What are your expectations after this pilot study?".

Statistical analysis

Descriptive statistics were used to present the characteristics of the study population such as age, sex and country workplace. For continuous parameters, the statistics used to summarize the data were arithmetic mean, standard deviation (SD), non-

parametric median, first and second quartile (Q1 and Q3). A three-way ANOVA model was applied to investigate the change over time in continuous parameters. This model was performed with the variables “session”, “sex”, “country” and “session-by-sex” as fixed effects as the purpose of this study was to evaluate the impact of the multi-country pilot intervention on specific worksites, by comparing the longitudinal results of two distinguished phases. In particular, the “session” factor was included in the model as it was the specific focus of our study, that is the comparison between the baseline (T0) and the follow-up (T1) results. The “country” factor was included in the model in order to take into account potential differences across countries, hypothesizing that participants from France, for instance, would produce different results than participants from China. Both “sex” and “session-by-sex” factors were included in the model because, according to the literature[35], sleep parameters are expected to vary between males and females. Relative changes in means from the baseline, pooled sexes and countries, as well as session p-values were reported. Subsequent Tukey tests were conducted to determine session mean differences for both male and female employees.

For categorical parameters, frequency tables of participants by sex and session were reported with absolute count and percentage of participants within each category. A logistic regression model, with the same fixed effects as for the ANOVA model, was carried out to investigate the change over time in dichotomous parameters. Results were reported as the adjacent logit odds ratios (OR) and the corresponding p-values. More specifically, baseline (namely females) was chosen as the reference category for the session (namely sex) factor.

Effects were judged to be statistically significant if alpha<0.05. Statistical analyses were performed using the R software version 3.3.2 (2016-10-31) for Windows.

Ethics

Data of both phases across all eight sites were recorded in a unique database stored in France in accordance with the French data protection authority (Commission Nationale de l'Informatique et des Libertés, National Commission of Informatics and Liberties). The tablet application was designed specifically to protect personal data and keep processes anonymous. All participants' electronic mails addresses were removed immediately after the first phase. The study complied with all standards set by the 1964 Declaration of Helsinki and its later amendments. A consent form explaining the study in each local language was signed at the beginning of the first phase by participants who were informed on (1) the purpose and procedure of the study, (2) the anonymous nature of their participation, and (3) the possibility to withdraw their participation in the study without any explanations at any moment.

Results

Characteristics of the sample

In total, 834 employees participated in the first phase of the study. All types of employees within the multinational company were represented: permanent contract, fixed-term contract, apprenticeship contract, temporary employees, service providers and trainees; 291 of them participated in the second phase of the study (34.9% follow-up participation rate). More particularly, participation rates across sites fluctuated between a minimum of 23.9% (Spanish site) and a maximum of 51.4% (one of the four Chinese sites).

Concerning the intervention population, i.e. the 291 employees included in the two sessions, female employees (n=164, 56.7%) and employees aged 18-34 years old

(n=105, 36.1%) represented the majority of the participants. The characteristics of the intervention population by country are presented in Table 1.

[Insert Table 1 near here]

Sleep status assessed at the baseline

On average, the 291 employees from all four countries reported 7.09 (SD= 1.02) hours of total sleep duration during the week, and 8.02 (SD= 1.29) hours during the week-end. The majority of employees slept ≥7 hours during the week (n=166, 58.0%) and during the weekend n=232, 81.1%), thus meeting the recommendations concerning sleep duration. The percentages of short sleepers during the week and the weekend were respectively 3.8% (n=11) and 1.0% (n=3).

Concerning sleep efficiency, the majority of the total study population reported ≥90% (n=143, 55.4%) during the week and ≥90% (n=135, 52.1%) during the weekend.

The average of sleep debt was 55.56 (SD= 68.41) minutes. Severe sleep debt (≥120 minutes) affected 17.8% (n=51) employees.

Insomnia was reported by 12.8% (n=37) employees, while sleepiness was reported by 1.4% (n=4) employees.

Sleep status assessed at the follow-up

Table 2 shows descriptive data about the first phase (T0) and the second phase (T1) by sex and differences between the two phases. These results were assessed for pooled sexes. Results by continuous variables are available as *Supplemental online material*.

The 291 participants having participated in both phases of the study reported an increase of total sleep duration during the week and during the week-end at follow-up.

This increase was statistically significant only for total sleep duration during the week-end (P=0.046): employees were about 1.2 times more likely to sleep ≥7 hours than between 5 and 7 hours.

Sleep efficiency during the week and during the week-end remained stable compared to baseline (OR close to 1).

Sleep debt significantly decreased at follow-up (P=0.019). Employees were 1/0.358 (about 2.8) times less likely to present severe sleep debt (≥ 120 minutes) at follow-up compared to baseline. Furthermore, sleep difficulties decreased significantly between the two phases (P<0.001) with total participants being 1/0.398 (about 2.5) times less likely to report them at follow-up. Furthermore, it was observed that female employees were two times more likely to suffer from sleep problems in both phases (P=0.006) (available as *Supplemental online material*).

Employees were 1/0.577 (about 1.7) times less likely to report sleepiness at follow-up (p=0.026).

[Insert Table 2 about here]

Feedbacks from participants

After the intervention, feedbacks and opinions from participants were collected. A total of 3 individuals (2 women, 1 man) volunteered to comment on the pilot intervention for further development and deployment. All interviewees were satisfied of the intervention, especially because it benefitted from the environment support. For instance, one of them affirmed: "I have participated in the WarmUapp™ intervention because I wanted to examine the way I take care of my health and well-being in a collective approach". Another participant said: "The program presented itself as a complementary element to my personal development, as a sort of balance sheet, an

appraisal of myself". The third participant said that the intervention had helped her to "know myself better and improve my health, through specific instructions and advice on what to do for my well-being".

Discussion

In line with prior research[24,26,36,37] and our hypotheses, we found that our blended intervention improved employees' sleep status, with statistically significant results concerning employees' total sleep duration during week-end, sleep debt, sleep difficulties and sleepiness. Our findings reinforced the assumption that workplace is a potentially ideal site for delivering health promotion programs, resulting in a benefit to both employees and employers. Furthermore, interventions using the many promising characteristics of digital technologies can increase engagement and consequentially be more effective among employees of organisations which are highly employing new media and technologies[23].

However, this intervention was not purely digital, but included human support. This multicomponent design could explain the success of WarmUapp™ whose tablet application was mostly conceived as a medium to facilitate the exchanges between employees and health care professionals (nurses, coaches, dieticians, physicians). The scope of the tablet app was in fact to complement human interaction and not to replace it. On the one hand, visualising data was important to raise awareness and reinforce education messages, compared to the classic doctor-patient oral communication. On the other hand, health care professionals reinforced the messages and recommendations of the intervention, thus increasing the sustainability of behaviour changes[38]. In the case of complex health issues, especially where the health behaviours extend outside the

workplace environment, a purely web-based intervention may not be adequate and a multicomponent intervention, including human support, may be a better approach[23].

Following Kahn and colleagues' work[21], this study confirmed that the provision of information can actually improve knowledge about the benefits of good sleep hygiene. Increased awareness and comprehension of one's sleep status can lead to behaviour change and WarmUapp™ proved to be a potential solution to improve awareness of the importance of sleep hygiene practices.

Strengths of the intervention included its multi-centric design as well as the visibility given by communication supports which boosted recruitment and loyalty of employees across all sites. The intervention was highly communicated and proposed innovating actions in a friendly environment. Qualitative feedback from participants was very positive in terms of promoting a good working atmosphere. This was in line with growing evidence that health-promoting messages can induce positive changes in individuals' health behaviours[39]. The underpinnings of the WarmUapp™ project were the idea the workplace is the appropriate setting to promote health and wellbeing, thus reversing the image of the workplace as a source of stress and possible cause of sleep problems[25].The support of the top management and the involvement of all levels of the company organization, including ambassadors, were also positive for the intervention. The effectiveness of the intervention was further increased by its flexibility and adaptability to local needs. Another marked strength was the use of scientifically validated items to assess sleep problems.

This study is not without limitations. First, the sample was relatively small and resulted in poor statistical power with limited numbers of respondents in some categories. Possibly, a greater sample size would facilitate getting significant differences across countries, for instance. Second, the sample of our study was probably highly selective,

resulting from the attraction of employees without severe sleep disorders. It would be interesting to test whether the intervention could be efficacious also among employees affected by more serious insomnia symptoms, for instance. Furthermore, the fact that the sample was composed only by local employees knowing that the intervention was implemented by their employers might have introduced the possibility of social desirability bias. Third, the intervention was implemented in a highly technological company, which means that its impact might be less promising in other organisations whose employees are less familiar with digital media and tools. Hence, we cannot infer the transferability and generalizability of our intervention in other multinational private companies. The deployment and evaluation of this blended intervention in other organisations (less technologically developed, concerning other supply chains, located in other countries, etc.) would help assess the ecological validity of our study.

In conclusion, we provided an example of an effective workplace pilot intervention concerning sleep whose effect lasted up to six months. Our study contributes to strengthen the evidence base that interventions blending face-to-face sessions with web-based approaches may be effective in encouraging healthy behaviours, including good sleep hygiene, in the workplace[40].

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Figure captions

Figure 1. Screenshots of the questions of the WarmUapp™ tablet application (permission obtained from Sanofi)

Figure 2. Screenshots of results report and recommendations from the WarmUapp™ tablet application (permission obtained from Sanofi)